Stages in water loss in fruit and vegetables

Antonio de Ita A and Georgina Flores

Área de Ciencia de Materiales, Universidad Autónoma Metropolitana, Av. San Pablo 180, Azcapotzalco, Ciudad de México

E-mail: add@correo,azc.uam.mx

Abstract. We analyzes the different stages in the dehydration of fruits and vegetables. It was found to vary from a lettuce: as a sharp drop at low temperature, (arround 150 °C) to five stages in total, with a loss almost continuous to about 300 ° C, such as grapefruit, papaya and fig.The first section in your paper.

1. Introduction

In previous studies [1,2] we have determined the loss of water in fruits and vegetables and the results obtained are generally consistent with the literature, where there is much variety in certain specific values of the water loss. This is because most literature is found on the internet, is not very scientific, or made without a safe and repeatable method, except in the case reported by the Department of Health of Great Britain [3]. Which explains in detail how the various parameters were determined, the only problem is that the list of materials is very short compared to existing, for example, in Mexico.

As is known [1.2] fruits in "general" are formed by an average of 90% water, with an 8% carbohydrates or sugars, fiber 1.5% and the rest in protein, vitamins, minerals, flavors and pigments. While vegetables contain average just less water, 75% plus 10% carbohydrates or sugars, a little more fiber than fruit, 4%, also a little more proteins 3%, also contains besides lipids, calcium, carotenes, vitamins, flavors and pigments.

It is clear that these percentages vary a little in vegetables. Thus in the case of water, potatoes contain 77 % while envy has 95 %. Carbohydrates are present with 19 % in potatoes while spinach has only 1.3 %. In the case of fiber, beans have 6.5 % but zucchini only 1.2 %. Parsley has 4.4 % of proteins while lettuce contains only 0.9%. And finally in the case of lipids parsley has 0.4 % but lettuce has only 0.1 %. Fruits have a similar behavior; there are fruits with more and less water and so on with the different components.

2. Methodology

The water loss in fruits and vegetables were made in a Shimadzu Thermal Analysis, DTG-60 model. We obtained TGA, Thermo Gravimetric Analysis, and also DTA, Differential Thermal Analysis, although these curves are not shown here. The latter technique can determine transition temperatures. The temperature was varied from ambient to 300°C. The heating rate was 10°C per minute under nitrogen flow rate of 10 cm^3 per minute. The mass used was around 15 mg, only pulp and always shelled without outer skin or bone were used, except in some cases for comparison purposes.

3. Results

In previous studies we have shown curves of weight loss have a single step as lettuce or poblano chile, as shown in figure 1. From the room temperature to 300°C a loss of almost 95% occurs in the case of lettuce and 92% in the case of poblano chile.

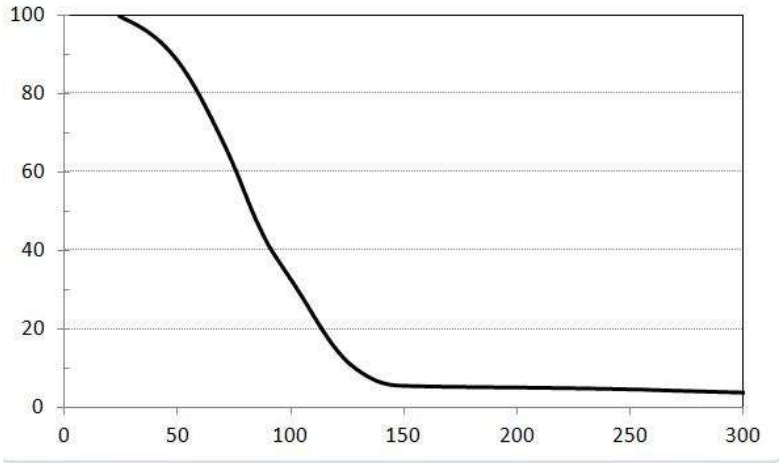

Figure 1. Graph of weight loss versus temperature of lettuce

But there are curves such as strawberry or melon where two stages very clearly, the first a period make a loss of over 82% and in the second stage falls only a 10% in both stages the fall is observed in the second part the loss is slow but continuous. In melon the first drop is more drastic but lighter in the second only 5% at 85°C. The strawberry result is shown in Figure 2.

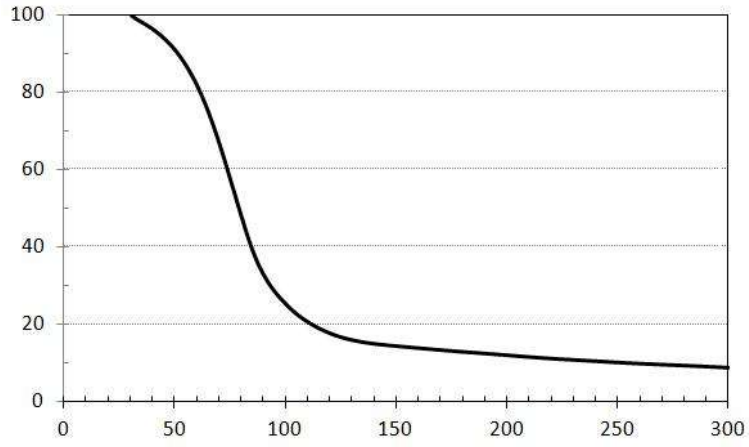

Figure 2. Graph of weight loss versus temperature of the strawberry

Three stages can be observed in pear and guava, as shown in figure 3 for the pear. The first loss is 84 % weight loss for about 140 °C, the second ends for 200 °C with a total loss of 88 % and finally the third stage though was not fully complete but at 300 °C there was a total loss of almost 95 %.

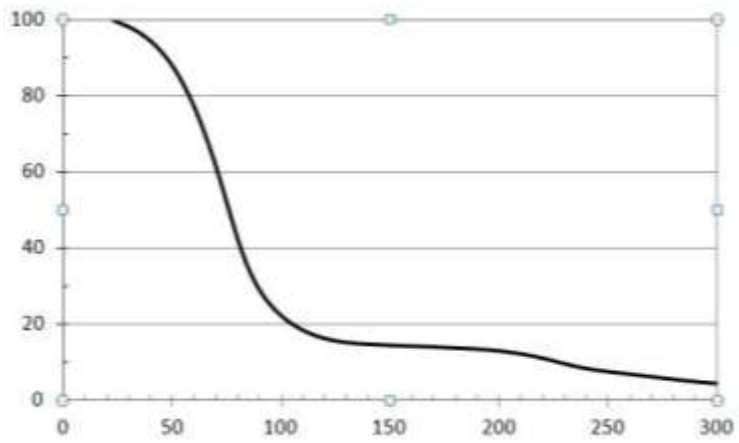

Figure 3. Graph of weight loss versus temperature of the pear

As one can see the values are very approximate therefore we develop a procedure to recognize in more detail what happens in the curve of weight loss. In this work, lines are drawn in each part of the curve and where two lines intersect a critical point, characterized by a temperature and weight loss was determined.

The idea is to determine whether there is a correlation in the different curves and identify more precisely the different stages. Thus in figure 4 is shown the grapefruit weight loss curve. Using straight lines a drop of 18 % is found at 58 °C, a second fall is related at 134 °C with a 85 %, total loss, the third stage is observed at 196 °C with a 90 %, total loss, at 229 °C a fourth stage with 93 % loss, finally the fifth loss is located where the experiment ends, at 300 °C with a 95 % total loss.

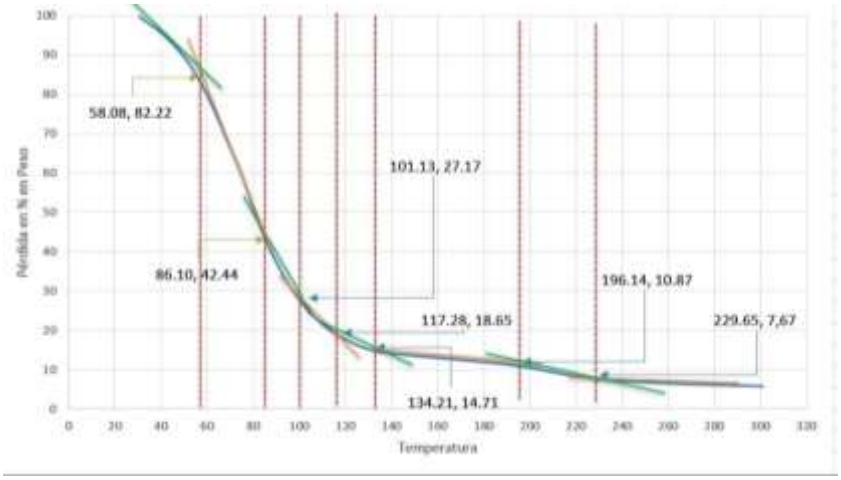

Figure 4. Graph of weight loss versus temperature for grapefruit

In figure 5 is another fruit, in this case, papaya is analyzed, the first stage is at 56 °C with a 13 % loss, the second is at 142 °C with 82% loss. The third stage is located at 200 °C with 85 % loss, the fourth at 224 °C and 86 % loss, the fifth finally, again located where the experiment ended at 300 °C and 90 % is the total loss.

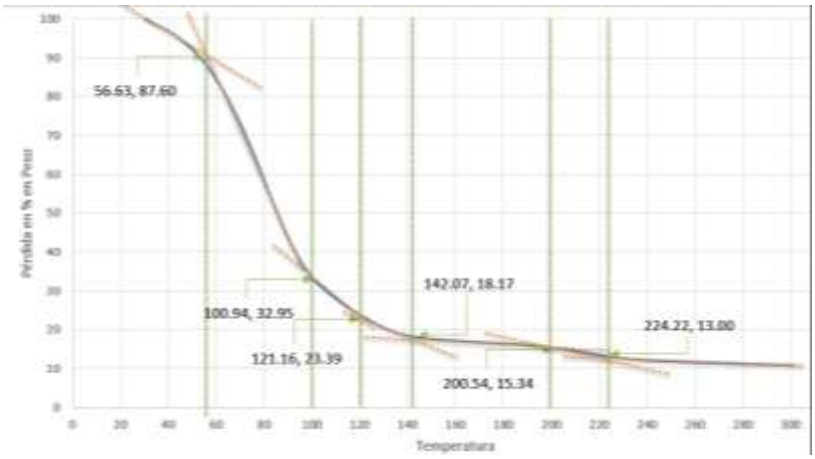

Figure 5. Graph of weight loss versus temperature for papaya

Fig fruit is presented in figure 6. Here we can also found in five weight loss stages. The first is at 77 °C with a 4 % loss, the second is at 146 °C with a 62 % total loss. The third ends at 206°C and represents a 4%, partial loss. The fourth stage is at 241 °C and a 6 % partial loss. The fifth and last is located where the experiment ends, at 300 °C and a 74 % total loss. In the last three cases it does not seem to finish the last stage and is variable for each of the tested materials.

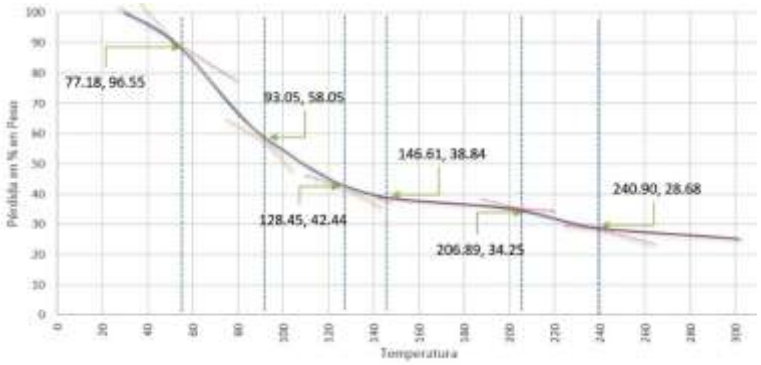

Figure 5. Graph of weight loss versus temperature for fig frut

4. Discussion

More stages especially in fruits were detected in the weight loss curves. On the one hand, it is recognized that because the major component present in fruits is water, the weight loss should be in less stages, but in fact is not. For the latter reasoning is that makes very reasonable that in the second stage is where is present the largest contribution to the weight loss and occurs between 100°C and 140°C in the last three examples shown here. In the grapefruit and papaya the second loss is 82% and only 62 % for the fig frut. For the final stage near to 300 °C the contributions are very small: 10 % for grapefruit, 8 % for papaya and 13 % for the fig frut.

Another interesting point to remember is that the curves of water loss can be classified by the lost amount and are: as banana or low, about 70 %. The medium or the average of fruits is about 90 % , the typical case is the poblano chile and finally the grater o height, with almost a total loss of 98 %, such as lettuce. This data is independent of the number of steps shown by the curves.

According to its curve evolution, or the number of stages in which the weigh is lost, we belied that the two first stages can be associated to water loss..

To analyze whether the second component, carbohydrates, have an important contribution and there is a possibility that the other minor components such as fiber, protein, vitamins, minerals, flavors and pigments have a chance to contribute somehow weigh losses is to investigate. It is possible because their molecules can decompose with temperature, but as we know their presence is minimal.

5. Conclusions

We proposed a new graphical procedure, which can be determined up to 5 stages in the weight loss. The first two stages, below 150°C can be associated with water loss.

6. References

[1] De Ita A, Flores G and Franco F Fruits and vegetables dehydration. 2015 VII International Congress of Engineering Physics, *IOP Publishing, Journal of Physics: Conference Series.* **582** 1-5 012065, doi:10.1088/1742-6596/582/1 /012065

[2] Antonio de Ita, Flores G and Franco F 2015 Determinación de la Pérdida de Agua de Frutas y Verduras por medio de Termogravimetría VI Congreso Internacional de Docencia e Investigación en Química 23 al 25 de Septiembre, Universidad Autónoma Metropolitana Azcapotzalco

[3] Department Health 2013 Nutrient analysis of fruit and vegetables (U.K)

[4] Harlan J R 1987 Les plantes cultivées et l'homme ed Presses Universitaires de France (Paris-France)